
Space Weather Technical Forecast

Issued on Thursday, 01 December 2022 at 01:05 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: G1/Minor Geomagnetic Storm intervals likely with a chance of G2/Moderate Storm. This risk slowly declining until possible CME effects on Day 4 (04 Dec). Active electron fluence likely through much of the period.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with several low level C-class flares. There are currently three small and simple sunspot regions on the visible disc. AR3152, in the northwestern hemisphere, and two new regions in the northwest and in the southeast have all been fading in recent hours.

A filament eruption later on 29 Nov produced two slow CMEs, which may have an Earth directed component, most likely arriving during the early hours of 04 Dec. A further filament eruption earlier on 30 Nov may also have an Earth directed component, although evidence of this in imagery is limited.

Solar Wind / Geomagnetic Activity: Solar wind parameters, as measured by ACE and DSCOVR at L1, were indicative of a positive coronal hole High Speed Stream, likely from CH49 and CH51. Wind speeds have been Elevated or Strong, varying between 580-700 km/s. Density was around average or slightly above. The IMF, Bt, has been mostly Moderate, rising from 7 to 12 nT. The north-south component, Bz, varied between +10/-9 nT. The phi angle was predominantly positive (away from the Sun). Geomagnetic activity was Quiet to Active (Kp 2-4) with a G1/Minor Storm interval between 1800-2100 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 has remained at Background levels. High energy electron flux (greater than 2MeV) at GOES16 was at mostly high levels for much of the period, peaking at 9.44e3 at 30/1500 UTC, before dropping sharply after 30/1800 UTC. Fluence rose above the Active (1e8 integrated pfu) threshold during the period. Observed fluence at 01/0001 UTC was 1.88e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to remain Low, with isolated C-class flares considered likely. New regions are starting to appear on the east limb and may give an increase in flaring in the coming days. Until they become fully visible, however, any increase in flare risk is difficult to assess.

Solar Wind / Geomagnetic Activity: Slow CMEs from 29-30 Nov may have some Earth directed component, although confidence is low. Any arrival is most likely during the early hours of Day 4 (04 Dec), although with some uncertainty in this. Solar wind speeds are currently Strong due to coronal hole fast winds. Wind speeds are expected to remain Elevated to Strong through Day 1 (01 Dec), slowly waning through the following days, likely to near background levels by Day 4.

Geomagnetic activity is expected to be Unsettled to G1/Minor storm at first, with a chance of G2/Moderate storms. Activity is expected to slowly decline through the coming days to mainly Quiet to Unsettled levels as the fast wind wanes. Then an increase is possible either late Day 3

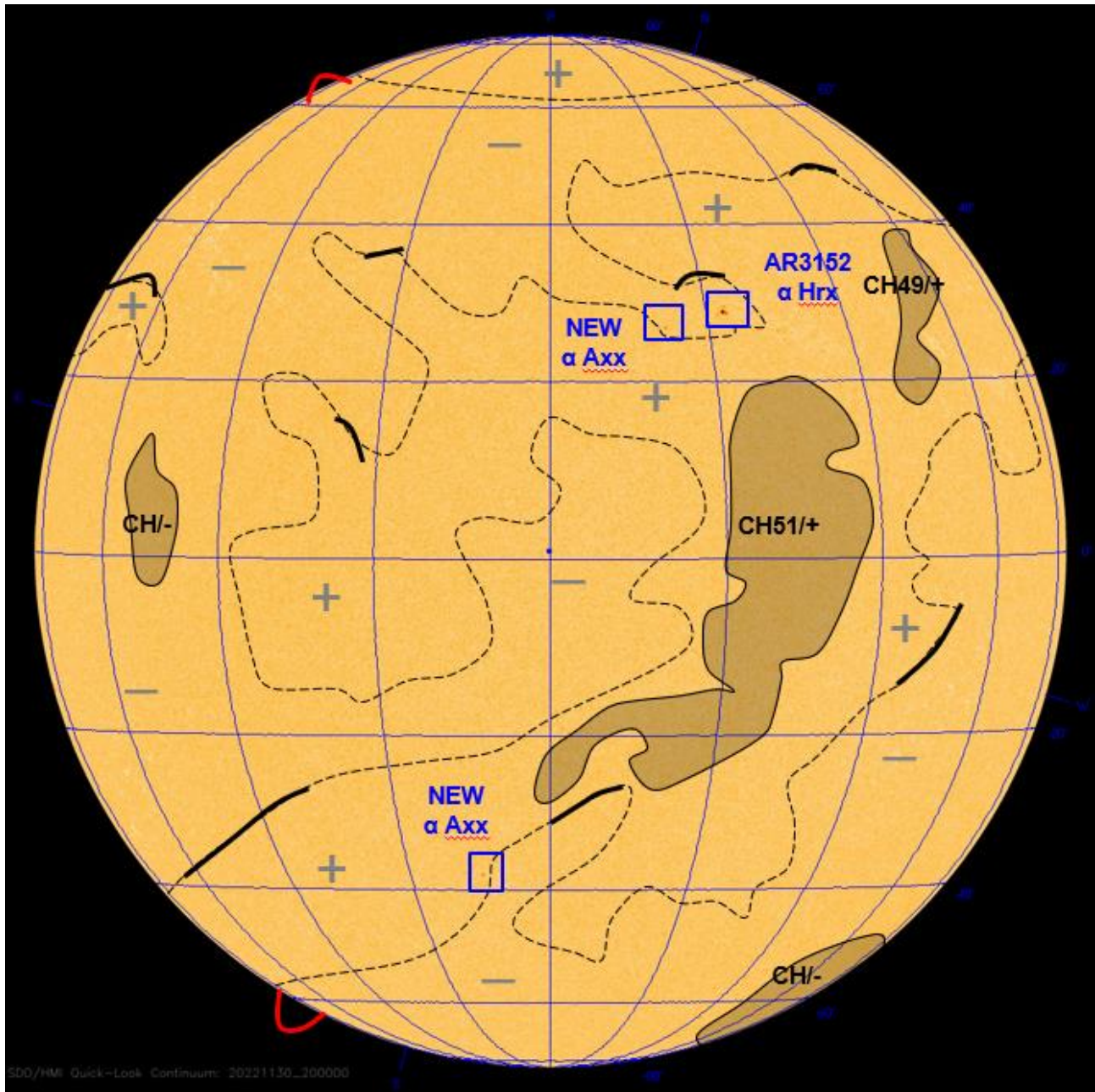
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or on Day 4 if we see any CME effects, with a slight chance of an isolated G1/Minor Storm interval.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) at GEO, as observed by GOES16, is currently at background levels and is expected to remain at this level throughout. High energy electron flux (greater than 2 MeV), as observed by GOES16, was at high levels before dropping sharply after 30/1800 UTC due to geomagnetic activity. The current HSS is expected to cause further charging. As the HSS wanes, an increase in electron flux is likely.

Fluence levels are currently above the Active ($1e8$ integrated pfu) fluence threshold, but are likely to have peaked in the short term with a brief declining trend, perhaps below Active, through the coming hours. Fluence levels are then likely to increase in the following days as the HSS wanes.

Figure 1. Solar Analysis Valid 30/2000 UTC.



Key: Filament ____, Prominence ____, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - γ - δ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

A filament eruption on 29 Nov resulted in two CMEs, with a further filament eruption on the 30 Nov perhaps producing another CME. All appear to be slow, with the possibility of an Earth directed component, although this is low confidence. Any arrival is most likely to occur during the early hours of Day 4 (04 Dec), although with some uncertainty in this.

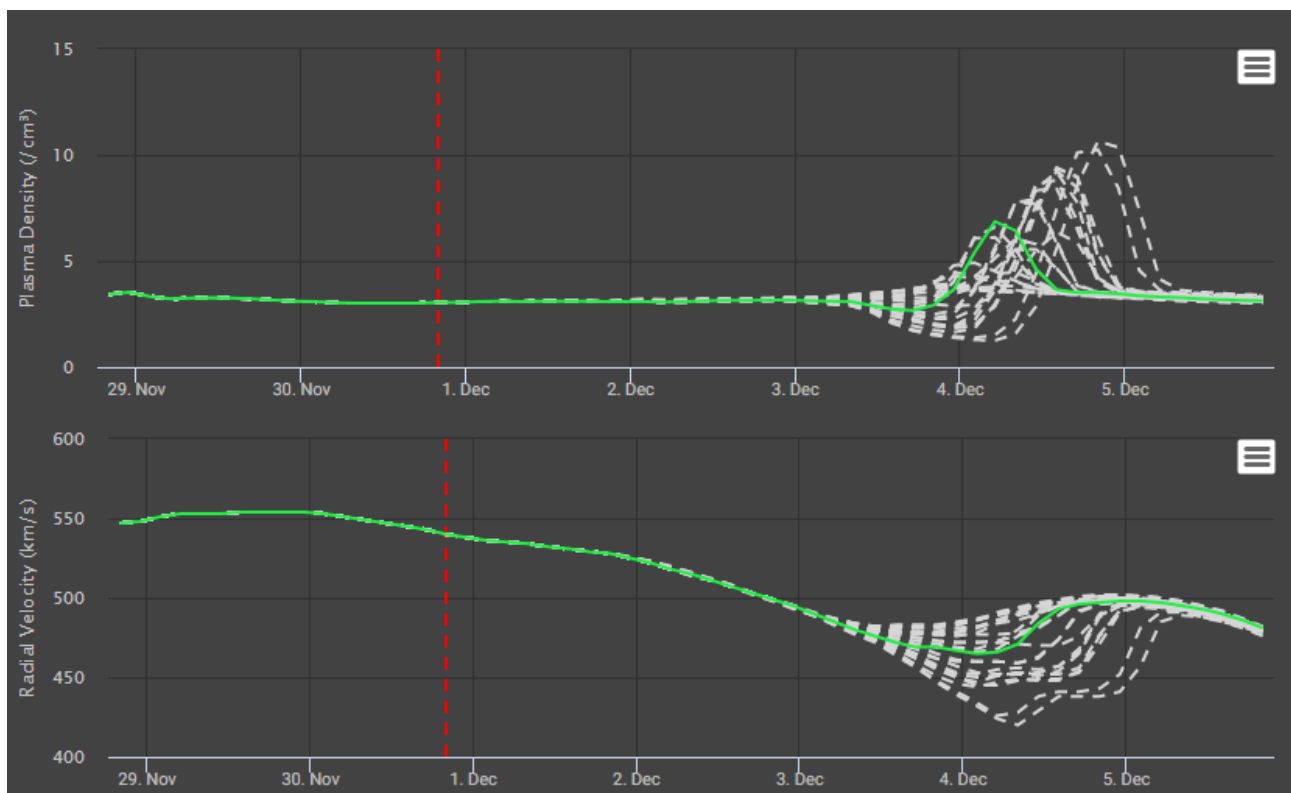
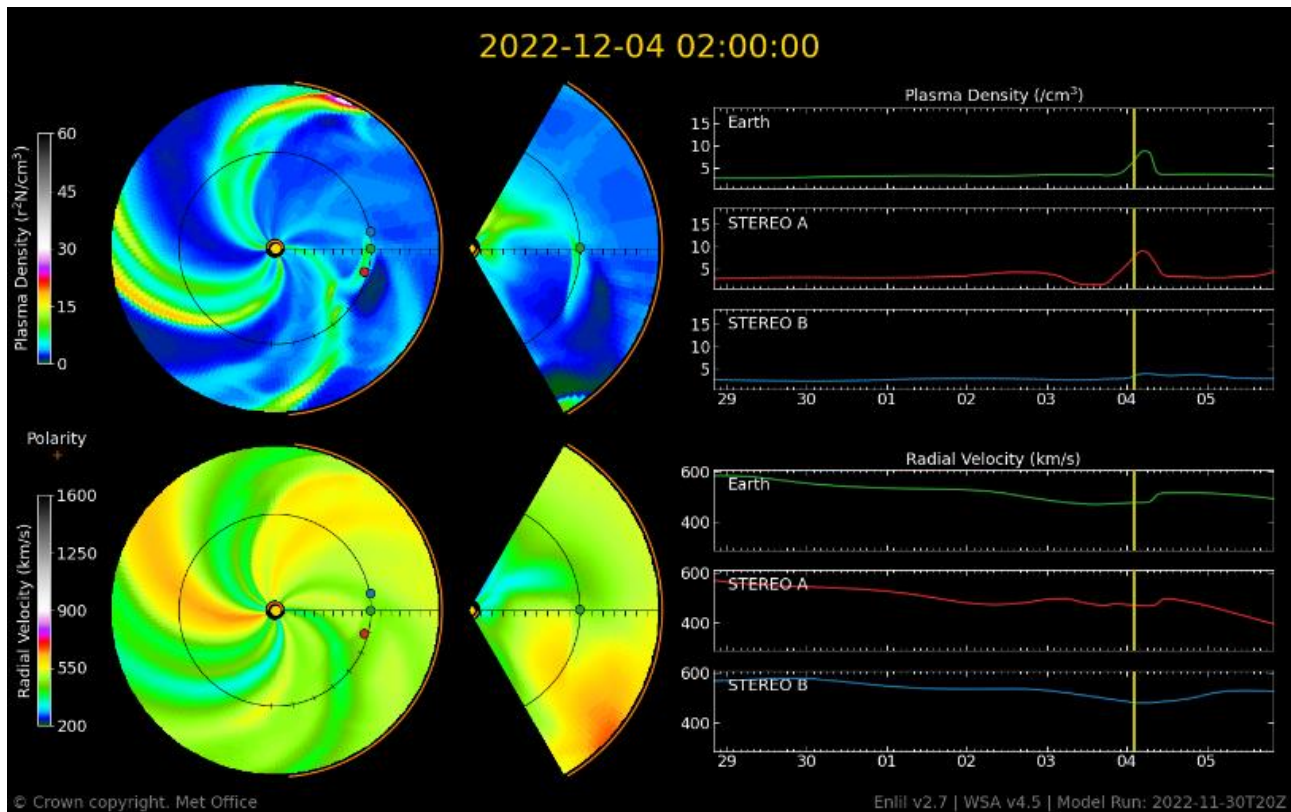
Solar wind speeds are currently Strong due to connections first with coronal hole 49 and then with coronal hole 51. Wind speeds are expected to remain Elevated to Strong through Day 1 (01 Dec), slowly waning through the following days, likely to near background levels by Day 4. Geomagnetic activity is expected to be Unsettled to G1/Minor storm at first, with a chance of G2/Moderate storms. Activity is expected to slowly decline through the coming days to mainly Quiet to Unsettled levels as the HSS from CH51 wanes. Then an increase is possible either late Day 3 or on Day 4 if we see any CME effects, with a slight chance of an isolated G1/Minor Storm interval.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	Yes	70	40	10	20
Strong	G3	No	2	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
30/0730	Partial	Filament eruption	SE quadrant	320 km/s	04/0600 UTC	Low confidence

Figure 2: MOSWOC Enlil and ensemble showing a possible CME arrival early on 04 Dec.



Radio Blackouts - X-Ray Flares:

Solar activity has been Low over the past 24 hours, with several low level C-class flares. There are currently three small and simple sunspot regions on the visible disc. AR3152 (Hrx/Alpha), in the northwestern hemisphere, and two new regions (both Axx/Alpha) in the northwest and in the southeast have all been fading in recent hours.

Activity is currently likely to continue to reach Low levels, however there is now evidence of a new region with spots starting to emerge on the southeast limb, although it is too early to classify this as it isn't fully visible yet. STEREO-A and far side imagery also suggests possible new regions to rotate onto the northeast limb within the next day or two. As none of these regions can be classified yet, a flat trend in the probability of flaring is maintained through the coming days, but an increase is possible once these regions become fully visible.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	5	5	5	5
Very Active	R3 to R5 X Class	No	1	1	1	1

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) at GEO, as observed by GOES16, is currently at background levels and is expected to remain at this level throughout the period.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	1	1	1	1
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm⁻²sr⁻¹s⁻¹)



High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy electron flux (greater than 2 MeV), as observed by GOES16, was at high levels before dropping sharply after 30/1800 UTC. This was due to increased geomagnetic activity associated with the ongoing HSS from CH49 and then CH51. This HSS is also likely to be compressing the main radiation belt inside the GEO orbit. Further charging is likely to be taking place from this HSS, and as it wanes, an increase in electron flux is likely.

Fluence levels are currently above the Active ($1\text{e}8$ integrated pfu) fluence threshold, but are likely to have peaked in the short term with a brief declining trend, perhaps below Active, through the coming hours. Confidence in this short term declining trend is moderate, although lower for the absolute values and levels may remain near the Active threshold. Fluence levels are then likely to increase in the following days as the HSS wanes. Confidence in an increasing trend is reasonable, but low for the timing of the increase. REFM is forecasting above Active through the next 3 days, although forecast values may be too high especially in the short term.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	Yes	100	50	60	70
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	2	5

Figure 3: MOSWOC REFM showing a forecast above Active ($1\text{e}8$ integrated pfu) for the next 3 days.

